

I claim:

1. Apparatus adapted to detect leakage from a faulty article, comprising:

(A) a tank having an interior adapted to hold a liquid bath such that said liquid bath has an upper surface when the tank is in a filled state, said tank including an observation region;

(B) a conveyor assembly including an advance portion operative to move in a longitudinal direction from an upstream location above the upper surface of the liquid to a downstream location above the upper surface of the liquid through an intermediate location below the liquid surface at a depth such that an article supported thereon is submerged in a submerged state wherein it is beneath the upper surface of the liquid bath as it moves past the observation region when the tank is in the filled state;

(C) a drive operative to advance said advance portion from the upstream location to the downstream location;

(D) a light source operative to illuminate liquid located in the observation region when said tank is in the filled state; and

(E) at least one optical detector disposed at the observation region and operative to monitor a monitored volume of liquid in a view field that has a horizontal view width and a vertical view height and that has a transverse view depth of field along a view line that extends substantially across said tank in a direction that is transverse to the longitudinal direction and in the observation region, said optical detector operative to generate a leak signal indicating a presence of bubbles of a selected bubble size in the monitored volume of liquid caused by gas escaping from a faulty article.

2. Apparatus according to claim 1 wherein said tank is elongated and includes an elongated bottom wall, an upstream end wall, a downstream end wall and first and second elongated sidewalls in spaced-apart, opposed relation to one another and extending between said upstream and downstream end walls thereby to define the interior thereof, and including a substantially transparent panel in said first elongated sidewall located at said observation region.

3. Apparatus according to claim 2 wherein said observation station includes a background associated with the second sidewall in opposed relation to said transparent panel, said background including a light absorbing material.

4. Apparatus according to claim 3 wherein said background is a black background and is defined by a light absorbing panel removably supported relative to said second elongated sidewall.

5. Apparatus according to claim 4 including a pair of spaced-apart, opposed channel pieces mounted on said second elongated sidewall thereby to define a slideway, said light absorbing panel sized and adapted to be slideably received therein.

6. Apparatus according to claim 1 wherein the advance portion of said conveyor assembly has an article support side adapted to support articles thereon.

7. Apparatus according to claim 6 wherein said conveyor assembly includes an endless conveyor belt defining having the advance portion and having a return portion, said advance and return portions extending between an upstream conveyor terminus and a downstream conveyor terminus, said return portion being located exteriorly of said tank.

8. Apparatus according to claim 7 wherein said conveyor belt is constructed of stainless steel.

9. Apparatus according to claim 7 wherein said upstream terminus and said downstream terminus are each located exteriorly of said tank.

10. Apparatus according to claim 6 including a magnetic hold-down assembly disposed proximately to the advance portion of said conveyor on a side thereof that is opposite the support side, said magnetic hold down assembly operative to magnetically retain submerged ones of said articles on said advance portion.

11. Apparatus according to claim 10 wherein said magnetic hold-down assembly includes at least one elongated bar magnet extending longitudinally of said tank.

12. Apparatus according to claim 1 wherein said light source is supported above the observation region.

13. Apparatus according to claim 1 wherein the light source includes fluorescent lights.

14. Apparatus according to claim 1 wherein said optical detector is an imaging processor.

15. Apparatus according to claim 1 wherein said optical detector is adjustable whereby the selected bubble size to be detected is selectively adjustable.

16. Apparatus according to claim 1 including a light hood disposed proximately to the observation region and operative to mask at least some ambient light against entering the observation region.

17. Apparatus according to claim 16 wherein said light hood includes a housing extending longitudinally of and above said tank.

18. Apparatus according to claim 17 wherein said housing includes at least one door opening and a door movable between an open position allowing access to

the advance portion of said conveyor assembly in the observation region and a closed position.

19. Apparatus according to claim 1 including a blow-off assembly disposed proximately to said conveyor assembly at a downstream location and operative to produce an air flow whereby at least some of the liquid residing on said articles after said articles are removed from the submerged state is removed by the air flow.

20. Apparatus according to claim 1 including electronic controls operative in response to the leak signal to disable said conveyor assembly thereby to stop advancement of said advance portion and to generate an alarm indicating detection of a faulty article.

21. Apparatus according to claim 1 wherein the longitudinal width and the vertical height of the view field is selectably variable.

22. Apparatus according to claim 1 including at least two said optical detectors disposed at the observation station and operative to monitor the monitored volume of liquid, said optical detectors each having different transverse view lines and operative to generate a leak signal indicating a presence of bubbles of a selected bubble size in the monitored volume of liquid caused by gas escaping from a faulty article.

23. Apparatus adapted to detect leakage from a faulty container that is among an ensemble of containers having a selected container height, comprising:

(A) an elongated tank having an interior adapted to hold a liquid bath such that said liquid bath has a upper surface when the tank is in a filled state, said tank including an elongated bottom wall, an upstream end wall, a downstream end wall and first and second elongated sidewalls in spaced-apart, opposed relation to one another and extending between said upstream and downstream end walls, said tank

including an observation station formed by a substantially transparent panel in said first elongated sidewall;

(B) a conveyor assembly including an endless conveyor belt having an advance portion and a return portion extending longitudinally between an upstream conveyor terminus and a downstream conveyor terminus, said advance portion having a container support side adapted to support containers thereon and operative to move in a longitudinal direction from an upstream location to a downstream location below the liquid surface at a depth that is greater than the container height when the tank is in the filled state whereby containers supported on the support side are submerged as they move past the observation region;

(C) a drive operative to advance said advance portion from the upstream location to the downstream location;

(D) a light source operative to illuminate liquid located in the observation region when said tank is in the filled state;

(E) an optical detector disposed at the observation station and having a view field that extends along a view line that is transverse to the longitudinal direction, said optical detector operative to generate a leak signal indicating a presence of bubbles of a selected bubble size in the liquid located in the observation region caused by gas escaping from a faulty container; and

(F) electronic controls operative in response the leak signal to disable said conveyor assembly thereby to stop advancement of said advance portion and to generate an alarm indicating detection of a faulty container.

24. Apparatus according to claim 23 wherein said observation station includes a background associated with the second elongated sidewall in opposed relation to said panel, said background including a light absorbing material.

25. Apparatus according to claim 24 wherein said background is black and is defined by a light absorbing panel removably supported relative to said second elongated sidewall.

26. Apparatus according to claim 25 including a pair of spaced-apart, opposed channel pieces mounted on said second sidewall thereby to define a slideway, said light absorbing panel sized and adapted to be slideably received therein.

27. Apparatus according to claim 23 wherein said return portion is located exteriorly of said tank.

28. Apparatus according to claim 27 wherein said upstream terminus and said downstream terminus are each located exteriorly of said tank.

29. Apparatus according to claim 23 including a magnetic hold-down assembly disposed proximately to the advance portion of said conveyor on a side thereof that is opposite the support side, said magnetic hold down assembly operative to magnetically retain submerged one of said containers on said advance portion.

30. Apparatus according to claim 29 wherein said magnetic hold-down assembly includes at least one elongated bar magnet extending longitudinally of said tank.

31. Apparatus according to claim 23 wherein said optical detector is an imaging processor.

32. Apparatus according to claim 23 including a light hood disposed proximately to the observation station and operative to mask at least some ambient light from against entering the observation region, said light hood including a housing extending longitudinally of and above said tank.

33. Apparatus according to claim 32 wherein said housing includes at least one door opening and a door movable between an open position allowing access to the advance portion of said conveyor assembly at a location associated with the observation region and a closed position.

34. Apparatus according to claim 23 including a blow-off assembly disposed proximately to said conveyor assembly at a downstream location and operative to produce an air flow whereby at least some liquid residing on said containers after said containers are removed from the submerged state is removed by the air flow.

35. A method of detecting a leak in an article, comprising:

- (A) providing a liquid bath having an upper liquid surface;
- (B) placing the article at an observation region wherein the article is submerged beneath the upper surface of said liquid bath;
- (C) illuminating the observation region;
- (D) monitoring the observation region by means of at least one imaging processor in order to detect bubbles of a threshold size emanating from a faulty article; and
- (E) generating a control signal in response to the presence of a bubble having a size equal to or greater than the threshold size.

36. A method according to claim 35 wherein the step of placing the article at the observation region is accomplished by dynamically advancing the article past the observation region.

37. A method according to claim 36 wherein the step of advancing the article past the observation region is accomplished by supporting the article on an endless conveyor belt.

38. A method according to claim 37 wherein said conveyor belt has an upstream terminus and said downstream terminus each located exteriorly of the liquid bath.

39. A method according to claim 38 including the step of magnetically retaining the article on the conveyor belt while the article is submerged.

40. A method according to claim 35 including the step of heating the liquid bath thereby either to pressurize the article or to increase pressure in an already pressurized article.

41. A method according to claim 35 including the step of disabling the advancement of the article in response to the control signal.

42. A method according to claim 35 wherein the threshold size is selectively variable.

43. A method according to claim 39 including the step of blowing liquid off of the article at a downstream location after the article has exited the liquid bath.

44. A method according to claim 35 including the step of monitoring the observation region by means of at least two imaging processors in order to detect bubbles of the threshold size emanating from a faulty article.